Kinematics homework solutions:

(FALL 2001…some of these have not yet been discussed in class! Don't Panic!)

1.

A. The student using the upper coordinate system would measure the initial position as -1.5 m and the final position as -12 m. The other student would measure the initial position as 4.5 m and the final as -6 m.

B. Both students measure the same displacement. One student would subtract –12 m – (–1.5 m) = –10.5 m. The other would subtract –6 m – (4.5 m) = –10.5 m.

C. Position definitely depends on the choice of coordinate system. Displacement does not so long as both students choose the same positive direction. (Had one student chosen a coordinate system in which positive numbers increased to the left, that student would find a displacement of +10.5 m.

2. Disagree. If an object moves from +10 to +5, it has a negative displacement (–5), even though it has always had a positive position.

3. Each round trip involves a distance traveled of 8 m (4 m to the left then 4m to the right) but a displacement of 0 (the final position is the same as the initial position). Average speed is total distance traveled divided by duration, or 24 m / 6 s = 4 m/s. On the other hand, average velocity is displacement divided by duration, or 0 m / 6 s = 0 m/s.

4. Yes. It will be slowing down…as discussed in lecture today. If velocity is 55 mph West at t = 0 then 50 mph West at t = 20 seconds and then 45 mph at t = 40 seconds, then acceleration is (delta v) / (delta t) or 0.25 mph / s to the East!

5. Yes. Consider the ball thrown up in the air discussed in lecture today. Its acceleration always points down, but its velocity starts out pointing up, then goes to zero at the top of the motion, then points downward.

6. The ball's speed increases in all three cases. On the first hill, acceleration is constant. On the second hill, the slope of the hill decreases and so the acceleration also decreases. The third hill gets steeper as you go down, so the acceleration of a ball will also increase in magnitude as you travel down the hill.

7. Acceleration is change in velocity divided by change in time. The change in velocity here will be 18 m/s (3 m/s/s times 6 seconds). 'From rest' means 0 m/s. Thus the final velocity is 18 m/s.

8. Omitted. Answer is C.

9. Omitted. Answer is A. This object is moving with uniform motion, so velocity is constant and acceleration is zero.

10. Omitted. Answer is C. Change in velocity is 6 m/s and time interval is 3 s, so acceleration is 2 m/s per second.

11. In the first second, the block moves 2 m (displacement = +2 m). In the second second (!) it moves 3 m. The third second the block moves 4 m. And so on and so on… Thus the velocity goes from +2 m/s to +3 m/s to +4 m/s, and changes +1 m/s every second. Thus, acceleration is 1 m/s per second, which is choice B.

12. Omitted.

a. The velocity changes by 10 mph every second, so it will take another 2.5 seconds to change from 50 mph to 75 mph. Thus the velocity is +75 mph at 4:00:05.5 (5.5 seconds after 4PM).
b. Since velocity changes by 10 mph every second, 2 seconds after 4 PM its velocity can be found by adding +20 mph to the velocity at 4PM, or 20 mph + 20 mph = +40mph.
c. Yes, the car travels with constant velocity so distance traveled = v * Dt = (20 mph ) (1/12 hr) = 20 / 12 miles = 1.67 miles.
d. Not easily…

13.

e. The object is speeding up when its velocity and acceleration have the same sign. Since velocity is the slope of the x vs. t graph, and since the slope of this graph is positive, the object is speeding up when its positive slope is getting more positive, or when the graph is getting steeper. That corresponds to an interval starting at about t = 5.5 s and continuing until the end of the graph.
f. The object is slowing down when the graph is getting less steep. (See part a.) That corresponds to an interval staring at the beginning of the motion and continuing until about t=4 s.
g. If the graph is straight, that means velocity is constant. This graph is straight only between t = 4 s and t = 5.5 s. (Answers may vary…depending on how closely you scrutinize the graph.)

14.

a. The object is slowest when the absolute value of the slope of the position vs. time graph has its minimum value. In other words, when is the curve least steep? At point B, the slope is zero (a tangent line at this point will be horizontal.)
b. The object is speeding up when its velocity and acceleration have the same sign. Since velocity is the slope of the x vs. t graph. When the slope of this graph is positive, the object is speeding up when its positive slope is getting more positive, or when the graph is getting steeper. There are no points like that on this graph. When the slope of this graph is negative, the object is speeding up when its negative slope is

getting more negative, or when the graph is getting steeper. That corresponds to point F.

c. The object is slowing down when the graph is getting less steep. (See part a.) That corresponds to points C, D, and E.
d. The object turns around when its velocity goes from positive to negative or from negative to positive. At point B, the velocity is positive before, negative after, so the object turns around at point B.